

International Search Report

This application is based on a PCT application. However, the Office Action does not contain an indication that the references cited in the International Search Report of the PCT application have been considered. Applicants respectfully request that the next Office Communication contain an indication that the references cited in the International Search Report have been considered.

Traversal of Election of Species Requirement

In the Response filed on May 3, 2001, applicant made several arguments traversing the election of species requirement. However, the Office Action fails to take note and answer those arguments traversing the election of species requirements while failing to examine the non-elected claims. Applicants respectfully submit that the Office Action is incomplete for failing to respond to those arguments and request that the arguments be noted and answered in the next Office Action.

Rejection of Claims 3, 7, 10, 14, 18, 21, 28 and 32

The grounds for the obviousness rejection of claims 3, 7, 10, 14, 18, 21, 28 and 32 are set forth in part 2 on pages 2-3, part 5 on pages 5-6, part 7 on page 7, and part 9 on page 9, of the Office Action. Specifically, the rejection relies upon the second embodiment shown in Figs. 14A-14D of U.S. Patent No. 5,508,561 to Tago et al (this embodiment hereinafter being

referred to simply as "Tago"), U.S. Patent No. 6,049,130 to Hosomi et al, and the pyramid shape shown in Fig. 2 of Japanese Pat. 08191072.¹ Applicants respectfully traverse the rejection at least because it fails to establish a *prima facie* case that the cited references suggest each and every one of the combination of features recited in the rejected claims.

For example, the rejected claims recite "pyramidal bump electrodes" which are "bonded by thermal compression onto pad electrodes arranged on a semiconductor chip." The rejection acknowledges that the electrodes in Tago are not pyramidal bump electrodes, but asserts that the Hosomi patent teaches "using pyramid shaped bumps using conventional thermal compression" and that Japanese patent 08191072 shows "a variety of shapes including triangular/conical/square shaped pyramidal bumps bonded onto pad electrodes." The rejection concludes that it would have been obvious to "choose pyramidal shaped bump electrodes to achieve the desired bonding strength using Hosomi et al's and [Japanese patent 08191072] bump shape in Tago et al's device."

Applicants do not agree that the Hosomi patent teaches choosing pyramidal shaped bump electrodes or bump electrodes which are "bonded by thermal compression onto pad electrodes arranged on a semiconductor chip." The rejection refers to elements 6 and 7 in the Hosomi patent. Element 6 may be a

¹ The Office Action refers to this reference as "prior art." Applicants note that the reference was published less than one year prior to their claimed priority date and they reserve the right to show an earlier date of invention.

bump electrode but it is not pyramid shaped. Element 7 may be pyramid shaped, but it is not a bump electrode (or pad electrodes arranged on a semiconductor chip). Element 7 is an inner portion of a Cu lead of a tape-automated bonding (TAB) tape which is bonded to bump electrode 6 formed on semiconductor chip 1a (see col. 1, lines 20-60). The nature of the inner lead 7 is perhaps made more clear by Figs. 15 and 16 and the description thereof at col. 4, line 57, to col. 5, line 9.

Applicants do not agree that it would have been obvious to combine Tago and the Hosomi patent by modifying Tago to have pyramidal shaped bump electrodes. The Hosomi patent is concerned with voids formed between bump electrode 6 and inner lead 7 (see col. 2, lines 33-67). Although Hosomi may suggest changes to firmly form a bonding part between a bump electrode and an inner lead of a TAB tape, it does not suggest changing the shape of the bump electrode. Indeed, the shape of bump electrode 6 in the conventional embodiment shown in Fig. 20 is the same as the shape of bump electrode 6 in the embodiment shown in Fig. 1.

Applicants also do not agree that it would have been obvious to combine Tago and Japanese patent 08191072 by modifying Tago to include the pyramidal shaped bump electrodes shown in Fig. 2 of Japanese patent 08191072. Japanese patent 08191072 does not disclose bump electrodes which are bonded by thermal compression onto pad electrodes arranged on a semiconductor chip. Conductive resin terminal parts 3 and 4

are formed by making a recessed portion 6 in a projection forming plate 5 and by printing a conductive resin material therein. This is described as an advantage in Japanese patent 08191072. Applicants respectfully submit that, if one of ordinary skill in the art were to modify Tago because of Japanese patent 08191072, then they would modify Tago to include terminal parts formed by making a recessed portion in a projection forming plate and printing material therein since that is described as an advantage in Japanese patent 08191072. Such a combination would not have bump electrodes bonded by thermal compression onto pad electrodes arranged on a semiconductor chip as recited in the rejected claims. Also, the base material of the bump electrodes in such a combination would be made of resin and the device would not have the features recited in claims 7, 21, 28 and 32. There is no reason why one of ordinary skill in the art would modify Tago only by changing the shape of the bump electrodes except for the hindsight afforded by this application.

Rejection of Claims 4, 11, 15, 19, 23, 25, 29 and 33

The grounds for the obviousness rejection of claims 4, 11, 15, 19, 23, 25, 29 and 33 are set forth in part 3 on pages 3-4, part 6 on page 6, part 8 on page 7 and part 10 on page 8 of the Office Action. Specifically, the rejection relies upon the second embodiment shown in Figs. 14A-14D of U.S. Patent No. 5,508,561 to Tago et al (this embodiment hereinafter being referred to simply as "Tago"), U.S. Patent No. 6,049,130 to

Hosomi et al, and the pyramid shape shown in Fig. 2 of Japanese Pat. 08191072. Applicants respectfully traverse the rejection at least because it fails to establish a *prima facie* case that the cited references suggest each and every one of the combination of features recited in the rejected claims.

For example, the semiconductor device recited in claim 4 has "pyramidal bump electrodes" which are "bonded by thermal compression onto pad electrodes arranged on a semiconductor chip" so that "said pyramidal bump electrodes and said pad electrodes can form an alloy at the junctions by said thermal compression." The rejection acknowledges that the electrodes in Tago are not pyramidal bump electrodes and that an alloy is not "formed at their junctions by using conventional heating and compression processes"², but asserts that the Hosomi patent teaches "using the cone/pyramid shaped bumps using conventional thermal compression where a layer comprising an alloy such as Au/Sn . . . is formed at the junction due to intermetallic diffusion" and that Japanese patent 08191072 shows "a variety of shapes including triangular/conical/square shaped pyramidal bumps bonded onto pad electrodes." The rejection concludes that it would have been obvious to "choose pyramidal shaped bump electrodes to achieve the desired bonding strength using Hosomi et al's and [Japanese patent 08191072] bump shape in Tago et al's device."

² Claim 4 does not recite "conventional heating and compression processes".

Applicants do not agree that the Hosomi patent teaches choosing pyramidal shaped bump electrodes or bump electrodes which are "bonded by thermal compression onto pad electrodes arranged on a semiconductor chip" so that "said pyramidal bump electrodes and said pad electrodes can form an alloy at the junctions by said thermal compression." Element 6 in the Hosomi patent may be a bump electrode but it is not pyramid shaped. Element 7 may be pyramid shaped, but it is not a bump electrode (or pad electrodes arranged on a semiconductor chip). Element 7 is an inner portion of a Cu lead of a tape-automated bonding (TAB) tape which is bonded to bump electrode 6 formed on semiconductor chip 1a (see col. 1, lines 20-60). The nature of inner lead 7 and the construction of the device in the Hosomi patent is perhaps made more clear by Figs. 15 and 16 and the description thereof at col. 4, line 57, to col. 5, line 9. The Hosomi patent does not form an alloy at the junctions between bump electrodes and pad electrodes because it does not even have pad electrodes.

Applicants do not agree that it would have been obvious to combine Tago and the Hosomi patent by modifying Tago to have cone/pyramidal shaped bump electrodes or to have bump electrodes which are "bonded by thermal compression onto pad electrodes arranged on a semiconductor chip" so that "said pyramidal bump electrodes and said pad electrodes can form an alloy at the junctions by said thermal compression." The Hosomi patent is concerned with voids formed between an Au bump electrode 6 and an inner lead 7 of a TAB tape coated with

the plated Sn (see col. 1, line 50, to col. 2, line 67). Although Hosomi may suggest changes because of this structure, it does not suggest changing the shape of the bump electrode. Indeed, the shape of bump electrode 6 in the conventional embodiment shown in Fig. 20 is the same as the shape of bump electrode 6 in the embodiment shown in Fig. 1. Since the structure of Hosomi is different than that of Tago, there is no indication that Tago will suffer from the disadvantages of voids discussed in Hosomi.

Applicants also do not agree that it would have been obvious to combine Tago and Japanese patent 08191072 by modifying Tago to include the pyramidal shaped bump electrodes shown in Fig. 2 of Japanese patent 08191072. Japanese patent 08191072 does not disclose bump electrodes which are bonded by thermal compression onto pad electrodes arranged on a semiconductor chip. Terminal parts 3 and 4 are formed by making a recessed portion 6 in a projection forming plate 5 and by printing a conductive resin material therein. This is described as an advantage in Japanese patent 08191072.

Applicants respectfully submit that, if one of ordinary skill in the art were to modify Tago because of Japanese patent 08191072, then they would modify Tago to include terminal parts formed by making a recessed portion in a projection forming plate and printing a material therein since that is described as an advantage in Japanese patent 08191072. However, such a combination would not have bump electrodes bonded by thermal compression onto pad electrodes arranged on

a semiconductor chip as recited in the rejected claims. It also would not have an alloy formed at the junctions of pyramidal bump electrodes and pad electrodes by thermal compression as recited in the rejected claims. Also, the base material of the bump electrodes would be made of resin and the device would not have the features recited in claims 23, 25, 29 and 33. There is no reason why one of ordinary skill in the art would modify Tago only by changing the shape of the bump electrodes except for the hindsight afforded by this application.

Rejection of claims 5 and 24

The grounds for the obviousness rejection of claims 5 and 24 is set forth in part 4 on pages 4-5 of the Office Action. Specifically, the rejection relies upon the second embodiment shown in Figs. 14A-14D of U.S. Patent No. 5,508,561 to Tago et al (this embodiment hereinafter being referred to simply as "Tago"), U.S. Patent No. 6,049,130 to Hosomi et al, the pyramid shape shown in Fig. 2 of Japanese Pat. 08191072, and U.S. Patent No. 6,172,422 to Chigawa et al.

Applicants respectfully traverse the rejection at least because it fails to establish a *prima facie* case that the cited references suggest each and every one of the combination of features recited in the rejected claims. For example, the rejected claims recite "pyramidal bump electrodes" which are "bonded onto rewired metal conduction pads that are

electrically connected to pad electrodes arranged on a semiconductor chip."

The rejection relies upon the same grounds of rejection set forth for claim 3 for the feature of pyramidal bump electrodes. Applicants therefore traverse the rejection of claims 5 and 24 for at least the same reasons as the rejection of claim 3.

The rejection acknowledges that Tago, the Hosomi patent and Japanese patent 08191072 fail to show bump electrodes which are "bonded onto rewired metal conduction pads that are electrically connected to pad electrodes arranged on a semiconductor chip" as recited in claim 5, but asserts that it would have been obvious to do so "to achieve increased interconnection capability using Chigawa et al's wiring design." Applicants can find no indication that Chigawa teaches that a semiconductor device such as that disclosed in Tago should be modified to "increase interconnection capability". To the contrary, Chigawa appears to be concerned with productivity and reliability (see, for example, col. 1, lines 37-44; col. 2, lines 45-47; and col. 2, lines 49-67). Applicants respectfully submit that there is no reason why one of ordinary skill in the art would attempt to combine Tago, the Hosomi patent and Japanese patent 08191072 in the manner proposed in the rejection.

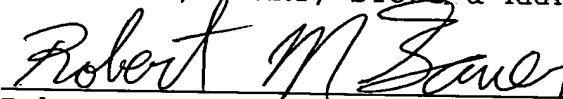
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Respectfully submitted,

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